COST AND PERFORMANCE REPORT

Pump and Treat of Contaminated Groundwater at the
JMT Facility RCRA Site
Brockport, New York

September 1998

Prepared by:
U.S. Environmental Protection Agency
Office of Solid Waste and Emergency Response
Technology Innovation Office

SITE INFORMATION

Identifying Information:

JMT Facility RCRA Site (previously Black and Decker)

RCRIS #: NYD002221919

Treatment Application:

Type of Action: Corrective Action

Period of operation: 5/88 - Ongoing
(Monitoring and pumping data collected through December 1997)
(Mass removal data collected through 1996)

Quantity of material treated during application: 50.1 million gallons of groundwater

Background

Historical Activity that Generated Contamination at the Site: Appliance Manufacturing

Corresponding SIC Code: 3699 (appliance manufacturing)

Waste Management Practice That Contributed to Contamination: Leaks from surface impoundments/drying bed

Location: Brockport, New York

Facility Operations: [1, 2, 3]

- The JMT Facility (formerly the Black and Decker site) is located on 28.5 acres in a largely industrial area. Several industrial plants are nearby, and an inactive hazardous waste disposal site is adjacent to the western boundary, crossgradient to the site.
- The site was operated as an appliance manufacturing facility by G.E. Company from 1949-1984 and by Black and Decker from 1984-1986. JMT Properties, Inc. is the current owner of the site and leases the facility to Kleen-Brite. Kleen-Brite uses the facility for packaging and wholesale distributing of household products (*e.g.*, laundry detergent, bleach).
- G.E. and Black and Decker operated an on-site RCRA treatment, storage, and disposal facility (TSDF) under interim status. The solid waste management units (SWMUs) included six surface impoundments, one drying bed, and three waste storage areas, which were significant sources of contamination.
- In 1984, routine sampling revealed elevated levels of halogenated volatile organic compounds (VOCs) in the groundwater below the SWMUs. This discovery led to a site-wide groundwater quality assessment program as required by the 40 CFR 265.93 regulations for groundwater monitoring.
- In response to the findings of the groundwater assessment, Black and Decker closed the regulated units in August 1987, and initiated a corrective measures program for groundwater in early 1988. For source control, Black and Decker removed the uppermost soil/sludge, backfilled excavations, and established vegetative cover.
- In 1987, Black and Decker submitted a RCRA Post-Closure Permit application to NYSDEC. The permit was issued on April 4, 1994 and requires that the system continue to be operated, maintained, and monitored until certain termination criteria are met. The permit required an Off-Site Ground Water Investigation (OSGWI) which was presented in August 1996.

Regulatory Context:

- Site activities are conducted under provisions of the Resource Conservation and Recovery Act (RCRA) in 1976, as amended by the Hazardous and Solid Waste Amendments (HSWA) in 1984, and 40 CFR 264 and 265 Subpart A through H.

SITE INFORMATION (CONT.)

- A National Pollutant Discharge Elimination System (NPDES) permit was required to discharge treated groundwater to the New York State Barge Canal.

Groundwater Remedy Selection:
Groundwater extraction and treatment via air stripping was selected as the remedy for this site.

Site Logistics/Contacts

Site Lead: Owner/Operator

Oversight:
New York State Department of Environmental Conservation (NYSDEC)

Remedial Project Manager:
Michael Infurna
U.S. EPA Region 2
290 Broadway
New York, NY 10007-1866
(212) 264-6150

Site Contact:
Paul William Hare*
Corporate Environmental Programs
General Electric Company
One Computer Drive South
Albany, NY 12205
(518) 458-6613

State Contact:
Larry Thomas*
New York State Department of Environmental Conservation (NYSDEC)
50 Wolf Road
Albany, NY 12233-7252
(518)457-9253

Treatment System Vendor:
Hydro Group, Inc. (1988-1997)
1011 Route 22
Bridgewater, NJ 08807
(908)704-8882

O'Brien & Gere Operations, Inc. (1997-Present)
5000 Brittonfield Parkway
Syracuse, NY 13221
(315) 437-8800

Technical Advisors to the Site Management:
O'Brien & Gere Engineers, Inc.
19 Walker Way
Albany, New York 12205
(518) 452-9392

*Indicates primary contacts.

MATRIX DESCRIPTION

Matrix Identification

Type of Matrix Processed Through the Treatment System: Groundwater

Contaminant Characterization

Primary Contaminant Groups: Halogenated VOCs

- The contaminants of concern at the site are trichloroethylene (TCE), *cis*-1,2-dichloroethylene *(cis*-1,2-DCE), 1,1,1-trichloroethane (TCA), and vinyl chloride.
- The maximum concentration of TCE detected in March 1988 was 70,000 ug/L in well 23-B. The maximum concentration of 1,2-DCE detected during the same time was 23,000 ug/L in well 18-S. Vinyl chloride and 1,1,1-TCA have been detected sporadically.

MATRIX SYSTEM DESCRIPTION (CONT.)

- The presence of DNAPL was investigated during the RCRA Facility Investigation (RFI). No evidene of DNAPL was found as a result of this investigation.
- The initial contaminant plume, shown in Figure 1, was estimated to be 30 feet thick and to cover an 11-acre area. Contamination was found to have migrated downward though the overburden into the fractured bedrock. The resulting plume is migrating in a northwesterly direction consistent with groundwater flow [2]. Plume volume could not be estimated given the subsurface variability.

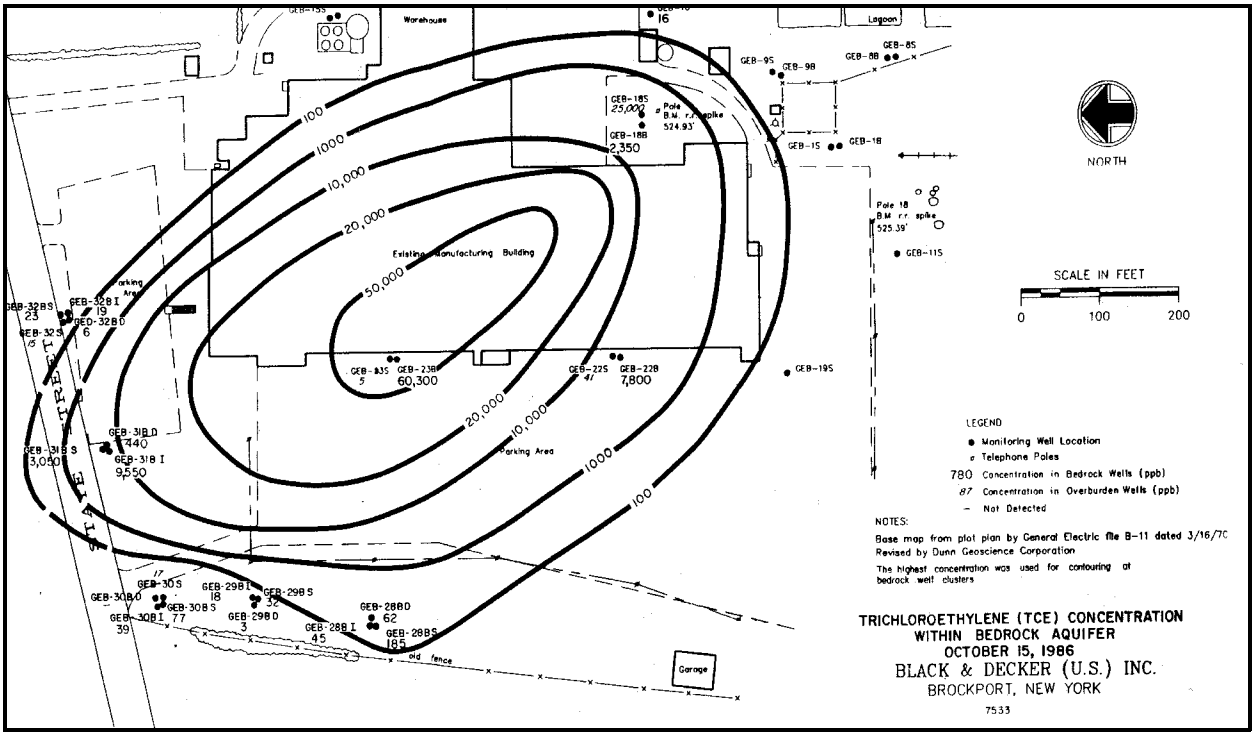

Figure 1. Initial TCE Concentration Contour Map (October 15, 1986) [5]

Matrix Characteristics Affecting Treatment Costs or Performance [2]

Hydrogeology:

Although subsurface materials at this site tend to function as a single hydrogeologic unit, due to differences in the geologic nature at this site of the materials, the site has been characterized as two units for EPA's remedial evaluation. The geology at this site is very complex, and the OSGWI has identified numerous hydrostratigraphic units. Information presented here is simplified for this discussion.

Unit 1	Overburden Aquifer	Silty fine to coarse sand and fine to coarse sandy silts with a little gravel and /or clay in places.
Unit 2	Bedrock Aquifer	Fractured sandstone interconnected to some degree with the overlying overburden materials.

MATRIX SYSTEM DESCRIPTION (CONT.)

The composition of both the overburden and bedrock units creates a complex environment for groundwater below this site. Groundwater flow is variable, less than 0.08 ft/day, and migration is very limited in the overburden aquifer. Groundwater flows along preferential pathways in the bedrock aquifer, complicating plume containment and monitoring. Furthermore, ambient water levels vary throughout the year to the extent that some of the overburden wells are dry for part of the year. On average, groundwater is encountered at 10 feet.

Matrix Characteristics Affecting Treatment Costs or Performance (Cont.)

Groundwater flows across the site in a northwesterly direction. The source areas are located in the central portion of the site. As the groundwater reaches the western side of the site it is captured in the fracture zone and extracted for treatment.

Tables 1 and 2 present technical aquifer information and technical well data, respectively.

Table 1: Technical Aquifer Information

Unit Name	Thickness (ft)	Conductivity (ft/day)	Average Velocity (ft/day)	Flow Direction
Overburden	5 - 20	0.93	0.0806	Northwest
Bedrock	150	0.65	0.078	Northwest

Source: [4]

TREATMENT SYSTEM DESCRIPTION

Primary Treatment Technology

Pump and treat with air stripping

Supplemental Treatment Technology

None

System Description and Operation

Table 2: Technical Well Data

Well Name	Unit Name	Depth (ft)	Yield (gal/day)
RW-1A	Bedrock Unit	40	16,150

Source: [3]

System Description [2, 3, 5]

- The groundwater extraction system consists of one recovery well (designated RW-1A) installed in 1987 as an interceptor well at the leading edge of the plume northwest of the former surface impoundments on the JMT facility, as listed in Table 2. The well placement was designed to prevent additional contaminants from migrating off site by achieving hydraulic containment [3].
- The initial plan for multiple conventional wells would not have been sufficient because of heterogeneity, as shown by pumping tests. The design engineers determined that one well placed at the toe

TREATMENT SYSTEM DESCRIPTION (CONT.)

of the plume in a blasted fractured zone would hydraulically contain the plume.

- To increase the degree of hydraulic conductivity and the interconnection in the bedrock fractures in the extraction well area, an interceptor drain was artificially created in the bedrock around the extraction well. Using controlled blasting techniques, a 300-foot long fracture zone was created in the upper 25 feet of the bedrock hydrogeologic unit, in effect "rubblizing" the upper portion of the bedrock. The blasted fracture zone was placed perpendicular to the direction of flow carrying the contaminant plume [2,3,5].

- The treatment system consists of a 57.5-foot packed-column air stripper tower with an internal diameter of 2.25 feet and a chemical feed system for addition of a sequestering agent to reduce bio-fouling. The tower is designed for a maximum flow of 100 gpm, and an air-to-water ratio of 75 to 1. The column was designed based upon 99.8% removal efficiency of TCE. Treated groundwater is discharged to the New York State Barge Canal under a SPDES permit [3].

- Two major modifications have been made to the system. In November 1995, an electrical and piping box was installed at the extraction well location, and a full-scale rehabilitation of the extraction well occurred during this same general time frame. In November 1996, an enclosure was constructed around the treatment system to provide heat and secondary containment.

- The groundwater quality is monitored quarterly in a core group of 15 wells and the extraction well. The discharge compliance monitoring for the treatment system is performed on a monthly basis as required by the SPDES permit.

System Operation [5, 6, 7-15]

- Quantity of groundwater pumped from the bedrock aquifer in gallons [5, 7-15]:

Year	Volume Pumped
1988	3,086,700
1989	4,865,000
1990	6,538,700
1991	4,222,300
1992	6,094,900
1993	7,054,800
1994	7,107,600
1995	3,787,100
1996	3,388,550
1997	3,924,750
Total	50,070,680

- As of December 1996, the treatment system was operational nearly 90% of the time. Shutdowns have been caused by periodic events, such as severe cold weather, ice storms, and lightning strikes. Downtime has also been influenced by rehabilitation, construction and maintenance activities [6].

- The air stripping media has only been changed once during the life of the treatment system in November 1995. A weak solution of nitric acid (5%) was used to remove scaling (bio-fouling) from the inside of the column and to loosen the packing [6]. Also in November 1995, a recovery well (RW-1A) rehabilitation was performed [13].

Operating Parameters Affecting Treatment Cost or Performance

The major operating parameter affecting cost or performance for this technology is the groundwater extraction rate. Table 3 presents the average extraction rate between 1988 and 1996, and the required performance parameters.

TREATMENT SYSTEM DESCRIPTION (CONT.)

Operating Parameters Affecting Treatment Cost or Performance (Cont.)

Table 3: Performance Parameters

Parameter	Value
Average System Extraction Rate	11.2 gpm
Performance Standard (Daily Maximum in SPDES permit)	TCE 0.026 kg/day *cis*-1,2-DCE 0.079 kg/day TCA 0.026 kg/day Vinyl chloride 0.132 kg/day
Remedial Goal (MCLs)	TCE 5 µg/L *cis*-1,2-DCE 5 µg/L TCA 5 µg/L Vinyl chloride 2 µg/L
Note: Average system rate was 11.2 gpm based on 46,145,650 gallons treated, system run time, and a 90% operational rate	

Source: [5, 7-15, 17]

Timeline

Table 4 presents a timeline for this corrective action project.

Table 4: Project Timeline

Start Date	End Date	Activity
1987	---	Remedial construction performed
1987	---	Artificial fracture created
5/88	---	P&T system placed into operation
4/94	---	Post-closure permit issued
10/94	1996	Installation of 40 off-site monitoring wells
8/96	---	Off-site groundwater investigation presented

Source: [2,16,17,18]

TREATMENT SYSTEM PERFORMANCE

Cleanup Goals/Standards

- Clean-up goals are set at New York State groundwater standards which are the Maximum Contaminant Levels (MCL) listed in Table 3 [17].

Additional Information on Goals

- The cleanup goals must be met in recovery well RW-1A [17]. The single compliance well is analyzed for Appendix IX constituents. However, termination criteria for the P&T system is also dependent on point-of-exposure wells, of which there are currently 17 [21].

TREATMENT SYSTEM PERFORMANCE (CONT.)

Treatment Performance Goals

- The goal of the treatment system is to reduce effluent contaminant concentrations to mass-based limits in order to meet SPDES permit requirements listed in Table 3 [2].
- The goal of the recovery system is to achieve hydraulic containment of the plume [6].

Performance Data Assessment [5, 6, 7-15, 18, 21]

For this discussion and Figures 3 and 5, total contaminant concentrations include TCE, 1,2-DCE, 1,1,1-TCA, and vinyl chloride.

- Figure 2 shows the trend in VOC concentrations detected in RW-1A from late 1987 to April 1988, before the system became operational, and from May 1988 through September 1997. As shown in this figure, concentrations of TCE declined 80% from 4,600 µg/L in December 1987 to 490 µg/L in September 1997. Concentrations of 1,2-DCE declined 91% from 1,600 µg/L in December 1987 to 140 µg/L in September 1997. Concentrations of contaminants remain above remedial goals [15].
- Groundwater monitoring results from May 1988 to December 1996 indicate that total contaminant concentrations have been reduced. Figure 3 illustrates changes in the average total contaminant concentrations in the groundwater over time. In the first year, average total contaminant concentrations declined 84% and average TCE concentrations dropped by a similar amount. Over the next six years, average total contaminant contamination declined by 80 percent [5, 7-15].
- In May 1996, the average concentration of TCE detected was 7 µg/L, while the maximum TCE concentration detected was 21 µg/L. Both the maximum and average concentrations are above the site cleanup levels.
- The use of blasting fractures to enhance conductivity in the fracture zone was an innovative approach to the challenges posed by the highly variable groundwater flow patterns at this site. Its effectiveness in enhancing the degree of conductivity and contaminant capture is demonstrated in Figure 4. In the first sampling episode after the zone was created in May 1987, TCE concentrations increased in wells GEB-31BD and GEB-32BI, both of which are directly downgradient of the fracture zone. However, as shown in the figure, these concentrations then decreased steadily in both wells [5, 7-11].
- During a 1994 -1996 post-closure investigation, contaminants were detected in off-site wells. However, the NYSDEC and the owner operator have concluded that the plume had been contained, and the off-site plume was believed to be residual contamination prior to pump-and-treat [21]. The addition of a new extraction well and a treatment system is currently being evaluated [16].
- The SPDES permit limitations have been met consistently since the permit was issued in May 1988 [6].
- Figure 5 presents the removal of contaminants through the treatment system annually from 1988 to 1996. During this time the P&T system removed approximately 842 pounds of contaminant mass from the groundwater [7, 18].
- The average system extraction rate is 11.2 gpm. Annual average pump rates have ranged from 8.2 gpm to a high of 13.5 gpm in 1994 [7,13].

TREATMENT SYSTEM PERFORMANCE (CONT.)

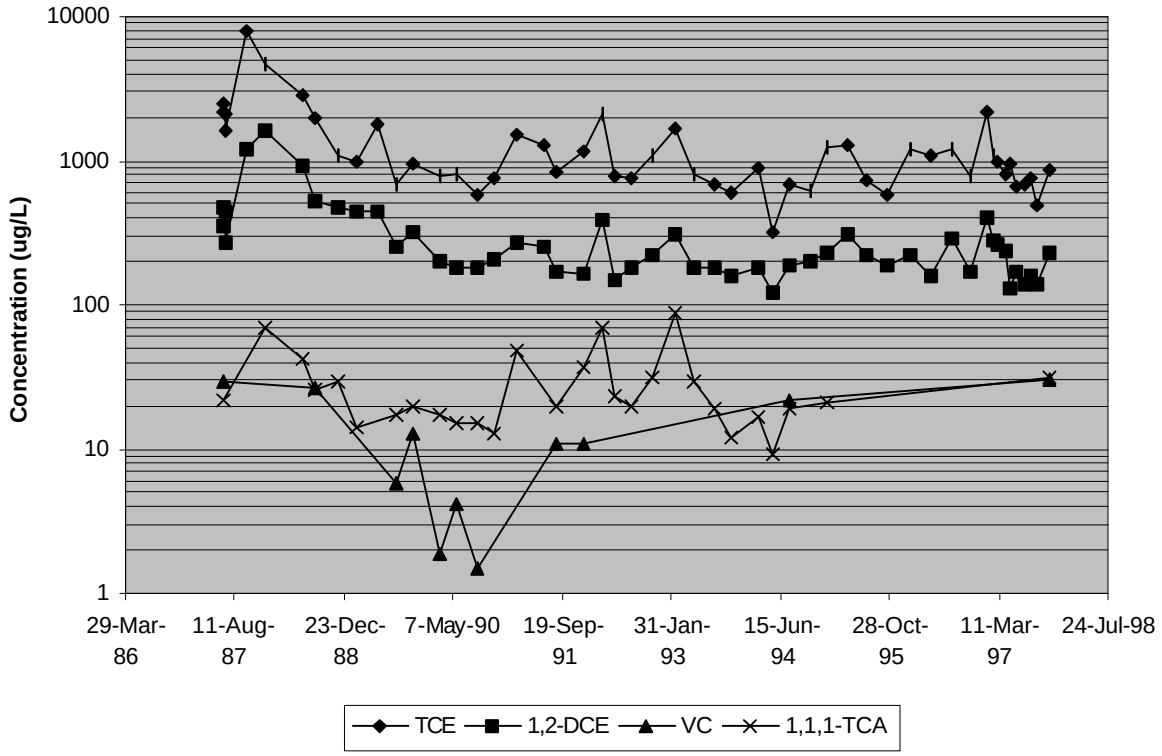

Figure 2. VOC Concentrations Detected in RW-1A (1987-1997) [5,7-15, 21]

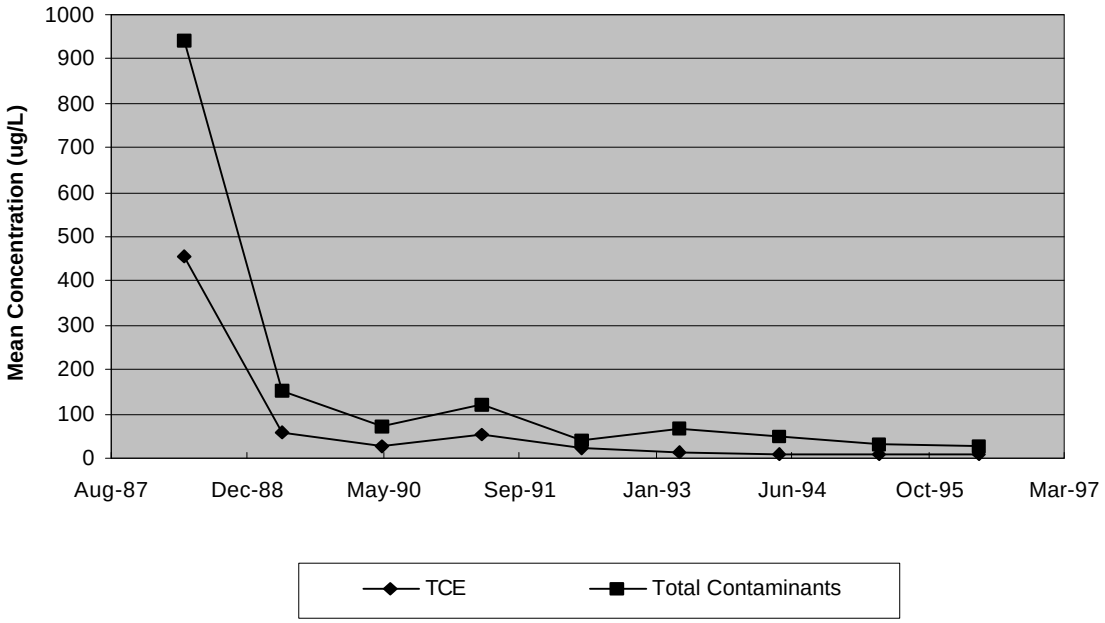

Figure 3. Average Groundwater Concentrations at the Toe of the Plume (1988-1996) [5, 7-15]

TREATMENT SYSTEM PERFORMANCE (CONT.)

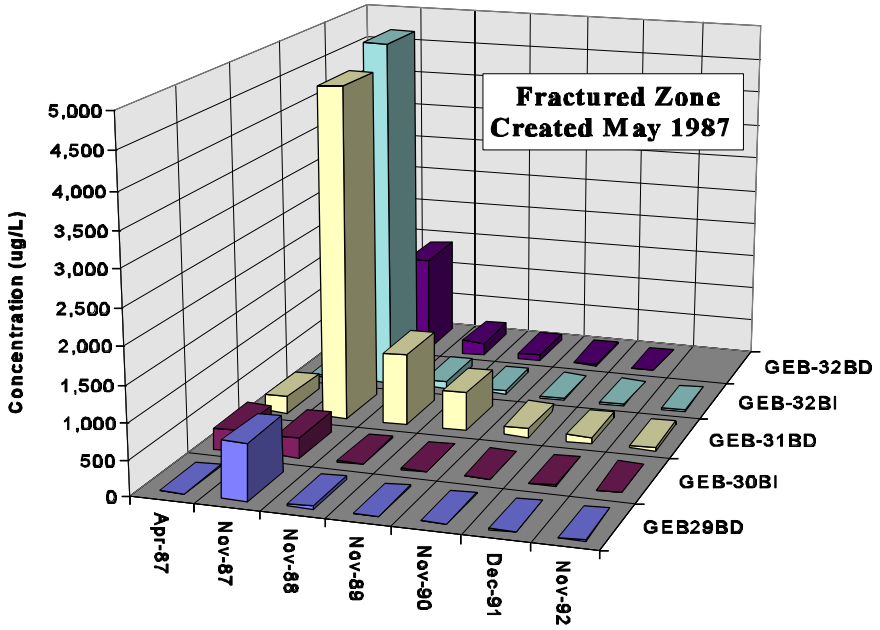

Figure 4. Well TCE Concentrations Near Fracture Zone [5, 7-11]

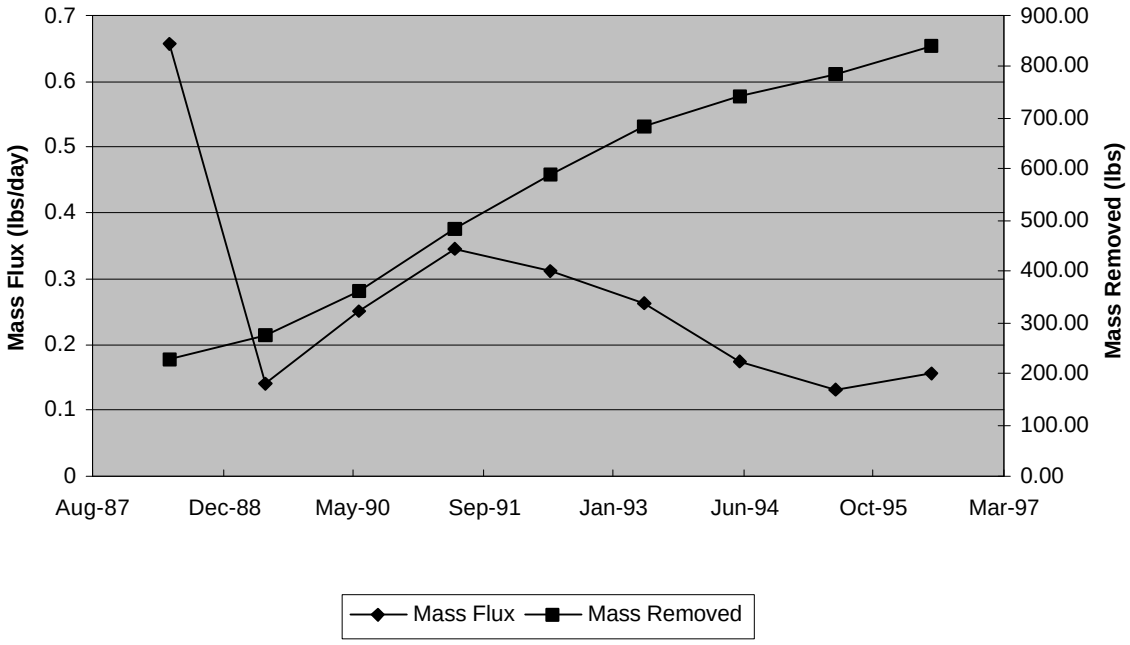

Figure 5. Mass Flux Rate and Cumulative Contaminant Removal (1988-1996) [7, 18]

TREATMENT SYSTEM PERFORMANCE (CONT.)

Performance Data Completeness

- Performance sampling for the treatment system is performed on a monthly basis. Data for the influent concentrations, effluent concentrations, and the system flow rate are available in the monthly SPDES Discharge Monitoring Reports (DMR). The analyses in Figure 2 are based on one month's data per year (June) collected from 1988 to 1996.
- Groundwater quality monitoring is performed during quarterly sampling events. A core group of 15 monitoring wells and the single recovery well are sampled for VOCs. Cyanide is monitored in the recovery well and 3 monitoring wells.
- A geometric mean was used for the average groundwater concentrations to represent the trend of contaminants in the groundwater at the toe of the plume. The second quarter monitoring event was used for annual data points plotted in Figure 3 of this report. A series of five well clusters throughout the plume, three wells in each cluster, has been used consistently to monitor the shallow, intermediate, and deep bedrock since 1988. A subset of five wells at the toe of the plume has been selected to document the effectiveness of the P&T system (i.e., GEB-28BS, GEB-29BD, GEB-30BI, GEB-31BI, GEB-32BI).

Performance Data Quality

The QA/QC program used throughout the corrective action met New York State requirements. All sample monitoring was performed using EPA-approved methods (SW-846 Methods 8010 and 9010), and the vendor did not note any exceptions to the QA/QC protocols unless otherwise noted.

TREATMENT SYSTEM COST

Procurement Process [6, 19]

G.E. contracted with Hydro Group, Inc. and its affiliate, Ground Water Associates, Inc., to construct and operate the remediation system, under the oversight of the NYSDEC. G.E. subsequently contracted with O'Brien & Gere Operations, Inc. for these services.

Cost Analysis

- Black and Decker and G.E. Company assumed all costs for investigation, design, construction, and operation of the treatment system at this site.

Capital Costs [6, 19]

Remedial Construction & Design	
Includes blasting of artificial fracture zone, pre- and post-blast pump tests, and construction of treatment system	$650,000
Enclosure building	$204,000
Piping and electrical enclosure at the extraction well - "hot-box"	$25,000
Total Site Cost	**$879,000**

Operating Costs [6, 19]

Annual Operation and Maintenance	
Includes all SPDES reporting, groundwater quality sampling, preparation of quarterly and annual reports, and maintenance costs	$150,000
Estimated Cumulative Total Operating Expenses (1987 to 1996)	**$1,284,000**

Cost Data Quality

The G.E. Company provided an estimate for actual capital costs, and an estimate of cumulative operating costs through 1997 [19].

OBSERVATIONS AND LESSONS LEARNED

- The total cost of treatment using the P&T system was $2,163,000, consisting of $879,000 in capital costs and $1,284,000 in estimated cumulative operating and maintenance costs through 1996 (assuming an average O&M cost of $150,000 per year) [6, 19]. According to the site contact, the cost of O&M has dropped significantly since 1988; largely because of more efficient O&M methods, decline in analytical service rates, upgrades, and less frequent non-routine maintenance requirements [6].

- Two modifications to the P&T system, enclosure of the treatment system and installation of a hot-box, resulted in an increase in capital costs totaling $229,000. Capital costs increased 35% over the original cost.

- The treatment system performance data indicate that approximately 842 pounds of contaminants were removed from the groundwater over 103 months at a cost of $2,569 per pound. As of the date of this report, the P&T system had not achieved cleanup goals [5, 7-15].

- Taking into account the cumulative cost of capital and operations and the volume of groundwater treated through 1996, the cost per 1,000 gallons treated was $47.

- Building an enclosure for the treatment system was a substantial cost. However, according to the site contact, the efficiency of the overall system has improved, especially in the winter months, and less time is needed for shutdown due to inclement weather. The cost-effectiveness of the enclosed building will be better determined in the future [21].

- Data indicate that the P&T system has reduced the contaminant concentration levels in the plume; however, contaminant concentrations in much of the plume remain above the established remedial goals [5, 7-15].

- Implementation of an artificially produced fracture zone in the bedrock was an innovative remedial alternative for this site. Through the use of controlled blasting, a selected zone of bedrock was transformed into a conduit which conveys groundwater to the single extraction well [20].

- Data from the RFI indicated that no significant amounts of DNAPL were present at the facility. The site engineer believes that the steady decline in contaminant concentrations in source areas is further evidence that no DNAPL contamination occurred at this site [6].

REFERENCES

1. Detailed Design for Treatment Enclosure, JMT Facility (EPA ID No. NYD002221919) Brockport, New York. General Electric Company Memorandum.

2. Evaluation of Ground Water Extraction Remedies: Phase II, Volume 2: Case Studies and Updates. U.S. Environmental Protection Agency. PB2-963346. February 1992.

3. Post Closure Permit Application, Part B. Appendix E-19: Treatment Facility Design. Hydrogroup. December 8, 1987.

4. Remedial System Performance Monitoring Plan, Black and Decker, Brockport, NY. Appendix E-26 of Post Closure Permit Application. Dunn Geoscience Corporation. January 11, 1989.

REFERENCES (CONT.)

5. RCRA Annual Groundwater Monitoring Report - 1987. Dunn Geoscience Corporation. March 1988.

6. Correspondence with Paul Hare, General Electric Company. June 2, 1997.

7. RCRA Annual Groundwater Monitoring Report - 1988. Dunn Geoscience Corporation. March 1989.

8. 1989 RCRA Annual Groundwater Monitoring Report. Dunn Geoscience Corporation. March 1990.

9. 1990 RCRA Annual Groundwater Monitoring Report. Dunn Geoscience Corporation. March 1991.

10. 1991 RCRA Annual Groundwater Monitoring Report. Dunn Geoscience Corporation. February 1992.

11. 1992 RCRA Annual Groundwater Monitoring Report. O'Brien & Gere Engineers, Inc. March 1993.

12. 1993 RCRA Annual Groundwater Monitoring Report. O'Brien & Gere Engineers, Inc. March 1994.

13. 1994 RCRA Annual Groundwater Monitoring Report. O'Brien & Gere Engineers, Inc. March 1995.

14. 1995 RCRA Annual Groundwater Monitoring Report. O'Brien & Gere Engineers, Inc. March 1996.

15. 1996 and 1997 RCRA Annual Groundwater Monitoring Reports. O'Brien & Gere Engineers, Inc. February 1997.

16. Off-Site Ground Water Investigation Report. O'Brien & Gere Engineers, Inc. August 1996.

17. RCRA Post Closure Permit. New York Department of Environmental Conservation. April 1994.

18. June SPDES Discharge Reports, Hydrogroup and O'Brien & Gere. June 1988-June 1996.

19. Personal communication with Lawrence Thomas, NYDEC. May 12-13, 1992.

20. Personal Communication with Paul Hare, General Electric Company. May 17, 1994.

21. Comments on draft report provided by Paul Hare, General Electric Company, and Larry Thomas, New York State Department of Environmental Conservation.

Analysis Preparation

This case study was prepared for the U.S. Environmental Protection Agency's Office of Solid Waste and Emergency Response, Technology Innovation Office. Assistance was provided by Eastern Research Group, Inc. and Tetra Tech EM Inc. under EPA Contract No. 68-W4-0004.

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